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FUNCTION OF RATS AND ON THEIR PROGENY

- USSR -

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FOREWORD

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EFFECTS OF IRRADIATED FOOD PRODUCTS ON THE REPRODUCTIVE
FUNCTION OF RATS AND ON THEIR PROGENY

- USSR -

[Following is the translation of an article by G. I. Bondarev of the Radiobiological Laboratory (Doctor of Biological Sciences S. R. Perepelkin, Director) of the Moscow Scientific-Research Institute of Sanitation and Hygiene imeni F. F. Erisman, in Voprosy Pitaniya (Problems of Nutrition), Vol XIX, No 6, Moscow, 1960, pages 18-22.]

The practical application of ionizing radiation for the preservation of food products is at present encountering some serious difficulties related to the solution of problems such as the quality, nutrition value, and innocuousness of the irradiated products.

Experimental data currently available makes it possible to conclude that many of the basic components of food products under the effects of ionizing radiation are practically undestroyed, with the exception of the vitamins. Vitamins are most sensitive to the effects of ionizing radiation, and the fact that some are destroyed must necessarily be related to the lowered food value of irradiated products. Simultaneously with such vitamins as para-aminobenzoic acid, vitamin B₁₂, and ascorbic acid, the tocopherols are also subject to considerable destruction with the application of sterilizing doses of radiation (Hannan, 1957; Kung, Gaden, King, 1953; Hannan, Shepherd, 1954; Bacq, Alexander, 1955; Ryer, 1956, and others).

In connection with the above, some investigators have carried out experiments for the study of the effects of irradiated food products on several generations of animals. They investigated gestation periods, duration of the lactation period, growth, development, viability of the animals, etc.).

The results obtained were quite diversified. In some instances, no effects of the irradiated products were observed upon either the sexual function of the animals, or on the growth and development of their young for several generations (L. A. Okuneva, 1958; Luckey, Wagner, Reyniers et al., 1955; Kraybill, Read, Friedemann, 1956; Metta, Johnson, 1956; Kraybill, Huber, 1957). In other cases it was established that a diet of irradiated food products produces in the animals a lowered sexual function in the males, raises the mortality rate in the young specimens

and causes a decrease in the number of offspring in the next generations (King, Becker, 1955; Kraybill, 1955; Poling, Warner, Humburg, Reber, Urbain, Rice, 1955; Becker, Kung, Barr, Pearson, King, 1956; Richardson, Brock, 1958). The enrichment of the irradiated rations with vitamin E completely or partially eliminated the above-mentioned phenomena. There have furthermore been reports that animals fed on food products irradiated with sterilizing doses of ionizing radiation, produce no progeny whatever and die after a period of four to five weeks (I. M. Buznik, 1959).

The contradictory character of the information available in literature on this subject may be explained by unequal conditions in the experiment set-up, the difference in the doses used for the irradiation of the food products, the variety in the amounts of irradiated products contained in the rations, etc.

The aim of the present work includes a study of the effects of certain irradiated food products on the reproductive function and on the progeny of rats. The special set-up of the experiment allowed us to judge the innocuousness and food value of the irradiated products. A study of the organoleptic properties of the irradiated food products was also carried out.

The products subjected to investigation were beef meat, codfish fillet, green peas, rye bread and oat groats.

The preparation and irradiation of the products was carried out at the All-Soviet Scientific-Research Institute of the Canning and Vegetable-Drying Industry. The products were irradiated with rays from a cylindrical Co^{60} unit with a working-volume dose equal to 630 R per minute. The aggregate dose for the irradiation of all of the products was 1,500,000 R.

Following irradiation, the products were stored from four to six months at normal room temperature and then were subjected to analysis.

Analysis of the organoleptic properties of the irradiated food products demonstrated the following.

All of the samples of beef meat possessed a pronounced specific odor, while some of them had acquired a moldy odor. The color of the meat, with the exception of a few samples, was scarcely changed. The samples of codfish fillet possessed an odor peculiar to this type of product; only a few individual samples had a strongly pronounced fish odor. The color of the codfish fillet varied from white to orange. The green peas were somewhat discolored, wrinkled, and had the odor of moldy hay. The rye bread had acquired a sourish odor and taste. The organoleptic properties of the oat groats were the usual, without any peculiarities.

For experimental purposes we took two groups of rats from one litter, one-and-a-half months old.

Each group of rats consisted of five females and two males, the animals of opposite sexes being maintained in separate cages. The rats of the first group (test rats) were fed irradiated food products, which formed 82% of the total weight of the ration. The rats of the second (control) group received non-irradiated products.

The ration contents for rats and the contents of the irradiated food products are adduced on the following page (Table 1).

Upon attaining the age of four months, the males and females of both groups were placed, respectively, into common cages for a period of three to three-and-a-half weeks. At the end of that period, the males were disposed of, and the females placed into separate cages and maintained on the previous rations for the duration of the gestation period, as well as through the birth of the young and the lactation period. One month following the birth of the progeny the adult females were sacrificed, and the young were placed into separate cages, according to sex. After the young had attained the age of one-and-a-half months, three groups of rats from the total number were kept: two test groups and one control group. The number of animals, as well as the ratio of males to females were maintained the same as in the initial groups.

These groups of animals were fed irradiated and control products, respectively, the rats of the test groups being daily fed, orally, an oil concentrate of vitamin E in a dose containing 0.03 gram of the vitamin. After that, the experiment was carried out as described above.

Observations of the reproductive function and the progeny of the rats were carried out by the following indications: the time of the birth of the offspring from the time of keeping the males and females in a common cage, the number of viable young, the growth and development of the young.

The results of the experiments are shown in Table 2.

Note: The assortment of food products adduced in Table 1 differs from that recommended by order of the Ministry of Public Health USSR No 745 of 11 September 1953. This is explained by the conditions of the experiments. In the preparation of the ration our aim was to increase up to the maximum the amount of irradiated food products in the experimental ration and to preserve the full physiological value of the control ration. Furthermore, all of the products entering into the experimental and control rations were fed to the rats without being subjected to thermal processing, in order to eliminate the effects of any such processing on the biological value of the food.

The results obtained by us testify to the fact that the feeding of rats with food products irradiated with sterilizing doses of ionizing radiation had a substantial effect on the sexual function of the animals, as well as on the growth, development and viability of the progeny.

Whereas in the control groups of the initial and first generation of the rats the gestation periods were, respectively, 28 and 29 days, in the test groups they increased, in the first generation by nine days, and in the second -- by five. The number of young born in the test groups of either generation was smaller than in the control groups. Thus, in the test group of the initial generation the number of young was 41 animals, as against 48 in the control group, and in the second generation -- 40 as against 54.

TABLE 1

Contents of Rations for Rats and the Irradiated
Food Products in These Rations

(A) № п/п	(B) Наименование продук- та	(C) Конт- роль- ный га- цион		(E) Опытный раца- он	
		(D) вес пищен- ных продук- тов в г	(F) вес необлу- ченных пище- вых продук- тов в г	(G) вес облучен- ных пищен- ных продук- тов в г	(G) вес облучен- ных пищен- ных продук- тов в г
1	Мясо говяжье	6	—	6	6
2	Тресковое филе	6	—	6	6
3	Хлеб ржаной	10	—	10	10
4	Крупя овсяная	10	—	10	10
5	Зеленый горошек	7	—	7	7
6	Молоко коровье	8	8	—	—
7	Дрожжи пивные	0,2	0,2	—	—
8	Рыбий жир	0,2	0,2	—	—
9	Соль	0,2	0,2	—	—

LEGEND:

A) Food product No; B) Name of Product; C) Control ration;
D) Weight of food products in G; E) Experimental ration; F) Weight
of non-irradiated food products in G; and G) Weight of irradiated
food products in G.

1. Beef meat; 2. codfish fillet; 3. Rye bread; 4. Oat groats;
5. Green peas; 6. Cow's milk; 7. Brewer's yeast; 8. Cod-liver
oil; and 9. Salt.

TABLE 2

Results of Observations of the Reproductive Functions
and of the Offspring of Rats

№ п/п	Показатель	Исходное поколение		Первое поколение		Второе поколение	
		подопытные	контрольные	подопытные	контрольные	подопытные	контрольные
1	Срок приноса потомства с момента совместного содержания самцов и самок (в днях)	37 (42, 44, 34, 35, 32)	28 (26, 28, 24, 30, 33)	33 (32, 30, 29, 43, 30)	29 (31, 31, 30, 27, 25)	27 (28, 26, 29, 27, 27)	27 (28, 26, 29, 27, 27)
2	Общее количество молодняка	41 (6, 6, 8, 9, 12)	48 (7, 7, 14, 9, 11)	40 (9, 8, 8, 8, 7)	47 (9, 9, 9, 10, 40)	54 (9, 12, 10, 11, 12)	54 (9, 12, 10, 11, 12)
3	Количество жизнеспособного молодняка	36	46	26	44	26	44
4	Появление шерстного покрова (в днях после рождения)			19 (15-24)	14 (12-16)	15 (13-16)	13 (12-13)
5	Прозревание (в днях после рождения)			21 (17-25)	17 (14-19)	18 (15-19)	16 (14-17)
6	Вес молодняка к одному месячному возрасту (в г)			30, 2 (18-50)	39, 2 (27-64)	32, 2 (17-51)	38, 4 (26-54)
7	Вес молодняка, к полуторамесячному возрасту (в г)			60, 8 (30-130)	80, 1 (60-105)	48, 3 (23-70)	70, 9 (50-90)
8	Отношение количества самцов и самок в потомстве			13 23	25 20	12 14	23 29

LEGEND: A) Food Product No; 1) Gestation period from the time of placing males and females in common cage (in days); 2) Total number of young rats; 3) Number of viable young rats; 4) Appearance of fur coating (in days after birth); 5) Acquisition of sight (in days after birth); 6) Weight of young rats by age of one month (in grams); 7) Weight of young rats by age of one-and-a-half months (in grams); 8) Ratio of males to females in the progeny; B) Indications; C) Initial Generation; D) First Generation; E) Second Generation; F) Test Group; G) Control Group; H) Test Group Receiving vitamin E.

A significant difference was observed in the number of viable young rats, especially in the first generation. Whereas in the test group of the first generation the number of non-viable animals was 14, in the control group that number was only two. In the initial generation this difference was less significant: five non-viable young in the test group, as against two non-viable young in the control group.

In weight, the young rats fed on irradiated food lagged considerably behind the control animals. Both in the first and in the second generations the difference in weight between the test young and the control young at age one-and-a-half months was equal to 20 gram.

Differences were also observed in the times of appearance of fur coating and acquisition of sight in the young rats. Thus, for example, in the test group of the first generation these periods were five days longer than in the case of the control animals. In the second generation this difference was less significant, amounting to two or three days.

In the rats of one of the test groups, which daily received orally the oil concentrate of Vitamin E, no significant differences were observed in the indications investigated as compared to the control animals.

Thus, feeding food products irradiated with sterilizing doses of ionizing radiation to rats produces longer gestation periods and a decreased number of young and of viable young, and affects the weight, growth and development of the progeny. The addition of an oil concentrate of vitamin E in the animals' ration almost entirely eliminates the above-mentioned effects.

The results obtained by us testify to the fact that the irradiation of food products with the above-mentioned doses causes a decrease in their nutrition value at the expense of the destruction of vitamin E, and possibly of other vitamins.

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